VP260 PROBLEM SET 5

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Problem 1.

(a)

$$I = \frac{U}{R+2r} = \frac{12-8}{1+1+8} = 0.4A$$

(b)

$$P_R = I^2 R = 1.28W$$
$$P_r = 2I^2 r = 0.32W$$

(c) In ε_1 chemical energy is being converted into electrical energy.

$$P = \varepsilon_1 I = 4.8W$$

(d) In ε_2 electrical energy is being converted into chemical energy.

$$P = \varepsilon_2 I = 3.2W$$

(e)

$$4.8W - 3.2W = 1.28W + 0.32W = 1.6W$$

Problem 2.

$$\begin{bmatrix} R_1+R_2 & -R_2 \\ -R_2 & R_2+R_3 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} -\varepsilon_1+\varepsilon_2 \\ -\varepsilon_3 \end{bmatrix}$$
$$i_1 = -\frac{99}{19}A \quad i_2 = -\frac{120}{19}A$$
$$I_1 = \frac{99}{19}A \quad I_2 = \frac{31}{19}A \quad I_3 = \frac{120}{19}A$$

Problem 3.

(a) When switch S is closed, the voltage on the bulbs doesn't change, so the brightness of them won't change.

(b)

$$U = \varepsilon \frac{R}{r+R} = \varepsilon\left(1 - \frac{r}{R}\right)$$

When switch S is closed, R becomes smaller, so U becomes smaller , and the brightness of the bulbs will be darker.

Problem 4.

(a)

$$Q_{max}e^{-t/RC} \leqslant e$$

$$t_d = RC \ln \frac{Q_{max}}{e} \approx 15.10s$$

(b) No. $t_d = RC \ln \frac{Q_{max}}{e}$, so it is dependent on R and C

Problem 5.

At point b,

$$\frac{U_b - 0}{M} + \frac{U_b - \varepsilon}{N} + \frac{U_b - U_c}{r} = 0$$

At point c,

$$\frac{U_c - 0}{X} + \frac{U_c - \varepsilon}{P} + \frac{U_c - U_b}{r} = 0$$

When $U_b = U_c$,

$$\frac{U}{M} \cdot \frac{N}{P} + \frac{U - \varepsilon}{N} \cdot \frac{N}{P} = 0$$

$$\frac{U}{MP/N} + \frac{U - \varepsilon}{p} = 0$$

$$X = \frac{MP}{N}$$